[0019] ICIC was introduced in Rel-8/9 of the 3GPP LTE standards. The basic idea of ICIC is keeping the inter-cell interferences under control by RRM methods. ICIC is inherently a multi-cell RRM function that needs to take into account information from multiple cells (e.g., resource usage status and traffic load situation).

[0020] Generally, the main target of any ICIC strategy is to determine the resources (e.g., bandwidth and power) available at each cell at any time. Then (and typically), an autonomous scheduler assigns those resources to users. Thus, from the RRC perspective, there are two kinds of decisions: (a) which resources to allocate to each cell, and (b) which resources to allocate to each user. Clearly, the temporality of such decisions is quite different. Whereas user allocations are on the order of milliseconds, the cell allocations span much longer periods of time or can be fixed.

[0021] Static ICIC schemes are attractive for operators since the complexity of their deployment is very low and there is no need for new or extra signaling. Static ICIC mostly relies on the fractional reuse concept. This means that users are categorized according to their SINR (essentially according to their inter-cell interference) and different reuse factors are applied to them, being higher at regions with more interference, mostly outer regions of the cells. The total system bandwidth is divided into sub-bands which are used by the scheduler accordingly.

[0022] For example, the users may be divided into two categories: Cell Center Users (CCUs) and Cell Edge Users (CEUs). CCUs are the users distributed towards the center of a given cell, whereas CEUs are the users distributed towards the edges of a given cell. CCUs can use all the frequency points to communicate with the base station, while CEUs must use corresponding specified frequency points to ensure orthogonality between different cells (e.g., since CEUs will necessarily be subject to inter-cell interference).

[0023] CEUs can be assigned a higher transmission power as the frequency reuse factor is greater than 1. The frequency points are not overlapped at the edges so the adjacent cell interference is small. CCUs frequency reuse factor is 1 as the path loss is small and transmission power is low. Therefore, the interference with adjacent cells is not high either.

[0024] Interference avoidance based on frequency-domain partitioning between different cells is of limited benefit for synchronization signals, PBCH, CRSs or control channels (e.g., PDCCH, PCFICH, PHICH). These are needed for initial access to the network and/or thereafter for maintaining the radio link. Therefore, their time-frequency locations are fixed (excepting CRSs, which can use a frequency reuse factor of 3 or 6 depending on the number of antenna ports configured) and frequency partitioning of these channels and signals would not be backwards compatible with Rel-8/9 UEs. However, the interference experienced by the pico cell UEs in a co-channel macro-pico deployment also affects these channels and, if large range expansion is employed, control channel reception at the pico cell UEs may fail, resulting in outage.

[0025] Such a need for interference mitigation of the control channels was the motivation for time-domain-based ICIC in Rel-10. The overall objective of eICIC is to mute certain subframes of one layer of cells in order to reduce interference with the other layer. These muted subframes are referred to as ABSs.

[0026] ABSs are subframes with reduced DL transmission power and/or activity. Ideally, ABSs would be completely blank in order to remove as much interference as possible. However, one still wants to balance the gains from interference reduction with the loss of transmission resources (e.g., from being unable to transmit PDSCH data in the ABSs). Furthermore, a desire for backwards compatibility means that cells must remain accessible and measurable for Rel-8/9 UEs. CRS is at least transmitted in ABS subframes so legacy UEs can use it for various measurements. In addition, PHICH is also transmitted in ABS subframes to avoid shutting off the corresponding uplink subframes. Nonetheless, even with these transmissions the ABSs can contain much less energy than normal subframes and, thus, reduce interference.

[0027] eICIC effectively extends ICIC to DL control in the time domain. eICIC requires synchronization at least between the macro eNB and the low power eNBs in its footprint, such as those eNBs, base stations or access points (e.g., HeNBs) that are serving femto or pico cells, for example. eICIC does not have a negative impact on legacy Rel 8 use (e.g., legacy UEs and legacy users).

[0028] RE refers to a UE's ability to connect and stay connected to a cell with low SINR. This is achieved with advanced UE receivers that use DL IC.

[0029] Use of both eICIC and RE techniques eliminates coverage holes created by closed HeNBs (e.g., privately operated HeNBs that do not allow for open, public access). Furthermore, these techniques improve load balancing potential for macro networks with low power eNBs and may lead to significant network throughput increase. In addition, these techniques enable more UEs to be served by low power eNBs, which can lead to substantially higher overall network throughput.

SUMMARY

[0030] This section contains examples of possible implementations and is not meant to be limiting.

[0031] An exemplary embodiment in a first aspect is a method, comprising: receiving, at a user equipment, a signal comprising cell-specific reference signals from a plurality of cells; measuring by the user equipment one or more cell-specific reference signals from one of the plurality of cells to determine one or more measured results; performing, by the user equipment and based on the one or more measured results meeting one or more first criteria, interference cancelation to cancel the one or more cell-specific reference signals corresponding to the one cell from the signal; performing, by the user equipment, the measuring and the performing the interference cancelation for additional ones of the plurality of cells until one or more second criteria are met; and using measured cell-specific reference signals having their interference canceled to reduce an effect of interference from corresponding cells on communications between a user equipment and a base station.

[0032] A method as above, further comprising receiving cell search information and using the cell search information for the measuring the one or more first cell-specific reference signals. A method as in this paragraph, wherein receiving search information further comprises receiving the cell search information from the base station, wherein the base station services a first cell of the plurality of cells, and wherein the first cell is a serving cell for the user equipment. A method as in this paragraph, wherein the cell search information comprises cell identifications, timing information, and cyclic prefixes for at least some of the plurality of cells. A method as in this paragraph, wherein the cell search information comprises a list of cell identifications, timing information, and